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Considerations For

ENVIRONMENTAL TESTING

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CONSIDERATIONS FOR ENVIRONMENTAL TESTING

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This paper outlines the requirement for environmental testing. It illustrates important considerations and problems in doing environmental testing, and suggests ways of alleviating them.

Proper force structure decisions involving many Air Force weapon systems depend upon tests in realistic weather. This has been vividly illustrated during analyses of tests of electro-optical munitions. During a program's initiation phase, it is Department of Defense (DOD) policy that operational test and evaluation (OT&E) be conducted in the most realistic environment possible (See Figure 1). The purpose of this policy is to determine the impact of the environment on operational system utility and to evaluate needed environmental support capabilities for optimal employment of the affected system. If the ultimate goal of eliminating system sensitivity to the environment is not feasible, this sensitivity must be understood and access to weather observations and forecasts assured to minimize corresponding environmental constraints.

OBJECTIVE OF ENVIRONMENTAL TESTING

DOD DIRECTIVE 5000.3, PROGRAM INITIATION PHASE, RECOMMENDS OT&E BE CONDUCTED IN THE MOST REALISTIC ENVIRONMENT POSSIBLE IN ORDER TO CLOSELY EXAMINE THE OPERATIONAL ASPECTS OF THE WEAPON SYSTEM.

- DETERMINE THE IMPACT OF ENVIRONMENT ON OPERATIONAL SYSTEM UTILITY
  - ELIMINATE ENVIRONMENTAL SENSITIVITY
- EVALUATE ENVIRONMENTAL SUPPORT CAPABILITIES NECESSARY FOR THE EFFECTIVE OPERATION OF THE TESTED SYSTEM
  - ENHANCE ENVIRONMENTAL SUPPORT TO ALEVIATE THE CONSTRAINT

FIGURE 1

DOD policy concerning environmental testing is explicitly provided in the OUSDR&E Memorandum approving the IR Maverick Test and Evaluation Master Plan (TEMP) (See Figure 2). The requirement to do realistic environmental testing is firmly established by this memo.

IIR MAVERICK TEMP

"...THIS SYSTEMS YEAR-ROUND EFFECTIVENESS IN VARIOUS ENVIRONMENTS INCLUDING INTENTIONAL AND INADVERTANT COUNTERMEASURES, AND ITS OVERALL SUITABILITY WHEN USED AND SUPPORTED BY TYPICAL SERVICE PERSONNEL, WILL RECEIVE INTENSE SCRUTINY AT DSARC III. THE THERMAL SIGNATURES AND ENVIRONMENTAL EFFECTS STUDY PROGRAMS SHOULD RECEIVE STRONG EMPHASIS THROUGHOUT THE REMAINDER OF THE FULL SCALE DEVELOPMENT PHASE..."

FROM: OSDR&E MEMORANDUM, JUN 24, 1980

FIGURE 2

Realistic environmental testing requires consideration of several factors. First, what are the environmental constraints on the system's operation (See Figure 3)? These can be expected to have been identified during research, development, test, and evaluation (RDT&E). OT&E should insure that system unique constraints are evaluated in light of the systems concept of operations.

MAJOR ATMOSPHERIC AND SOLAR EFFECTS ON PRECISION GUIDED MUNITIONS (PGMs) AND TARGET ACQUISITION (TA) SYSTEMS

PGM/TA SYSTEM	ENVIRONMENTAL LIMITATIONS	TIME OF EMPLOYMENT	SYSTEM RESOLUTION
EYE/TV (VISIBLE)	CLOUDS (INCLUDES FOGS) HAZE (INCLUDES ALL DRY AEROSOLS) SUN ANGLE	DAY (AVOID DAWN AND DUSK)	HIGH
SILICON VIDICON TV (VISIBLE AND NEAR IR)	PRECIPITATION LIGHT LEVELS	DAY (AND MOONLIGHT)	
LASER (INFRARED)	CLOUDS (OTHER THAN VERY THIN) HAZE (NEAR IR ONLY) ABSOLUTE HUMIDITY (FAR AND FAR FAR IR ONLY)	DAY OR NIGHT	NOT APPLICABLE
INFRARED	CLOUDS (OTHER THAN VERY THIN) HAZE (NEAR IR ONLY) ABSOLUTE HUMIDITY (FAR AND FAR FAR IR ONLY)	DAY OR NIGHT	MEDIUM
MILLIMETERWAVE/ MICROWAVE	HEAVY CLOUDS (HIGH LIQUID WATER CONTENT) PRECIPITATION REFRACTIVE INDEX	DAY OR NIGHT	LOW

SOURCE: AIR WEATHER SERVICE ELECTRO-OPTICAL HANDBOOK (VOL 1)

FIGURE 3

In order to do realistic testing, a location must be selected that provides a broad spectrum of the key environmental elements to be experienced in the theater of operations. The site must promise sufficient occurrences of these elements so as to provide an adequate sample of events for analysis purposes. The number of samples need not duplicate expected frequencies of occurrence in the theater of employment but should cover the important range of events. Site selection is the key to successful environmental tests. There are many test support related factors that determine whether realistic environmental testing can be done. Also, the means to collect needed data must be provided to document test conditions.

CONSIDERATIONS FOR ENVIRONMENTAL TESTING

- DETERMINATION OF ENVIRONMENTAL CONSTRAINTS
  - STANDARD ENVIRONMENTAL DESIGN/TEST CRITERIA
    - MIL STD 210B - DESIGN
    - MIL STD 810 - TEST
  - SYSTEM UNIQUE ENVIRONMENTAL CONSIDERATIONS
    - OPERATIONAL EMPLOYMENT CONCEPT
- SELECTION OF TEST LOCATION
  - PROVIDES BROAD SPECTRUM OF ENVIRONMENTAL CONDITIONS
    - SIMULATES OPERATIONAL ENVIRONMENT
  - OTHER CONSIDERATIONS
    - AVAILABILITY OF SUPPORT
    - LARGE CONTROLLED AREA
    - IMPACT AREAS
    - INSTRUMENTATION
    - NO AIRSPACE RESTRICTIONS
- COLLECTION OF DATA FOR SYSTEM ANALYSIS
  - DETERMINE PRECISION OF MEASUREMENTS
  - FREQUENCY OF MEASUREMENTS
  - LOCATION OF INSTRUMENTATION

FIGURE 4

There can be problems in using climatological data for test site selection as indicated by recent experience with the IR Maverick. Values of environmental factors such as cloudiness, visibility, precipitation (including snowfall), humidity, and temperature were compared from several potential test sites (See Figures 5-11). For reasons mentioned above, the chosen test sites experience the important weather conditions only 25 to 50 percent as frequently as the major employment area. Considering the limited number of missions to be flown, it's likely that desired test conditions would not be experienced during the OT&E of IR Maverick.

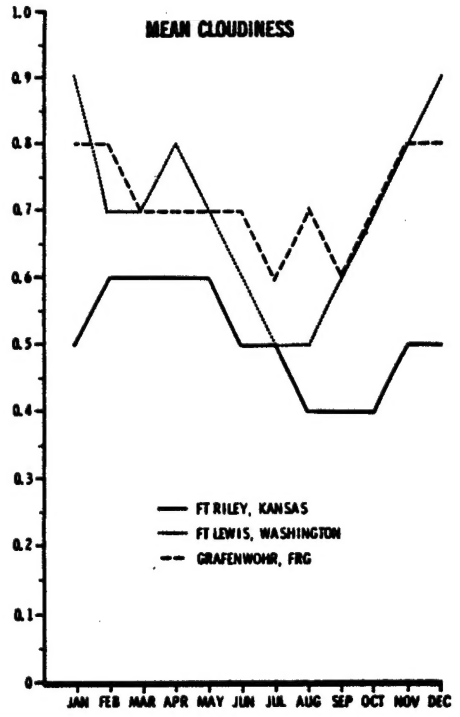

FIGURE 5

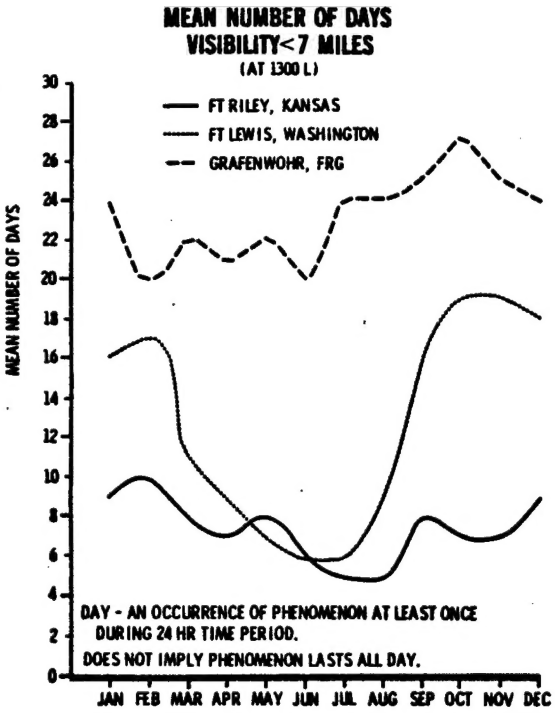

FIGURE 6

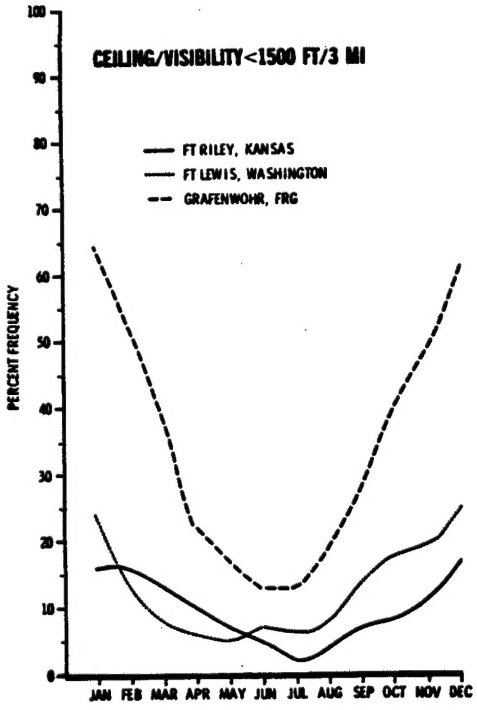

FIGURE 7

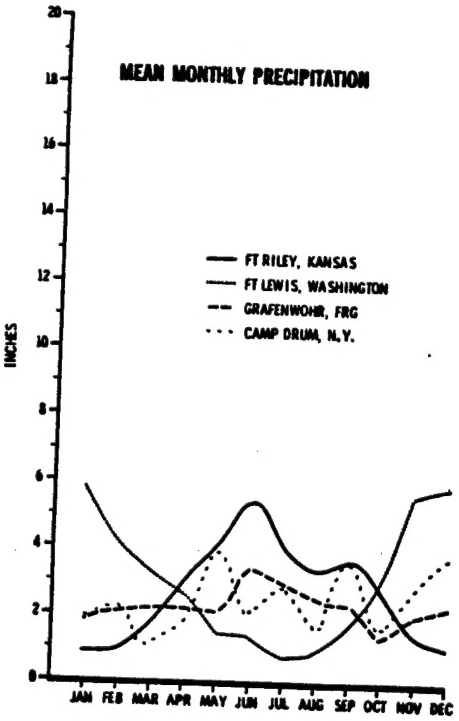

FIGURE 8

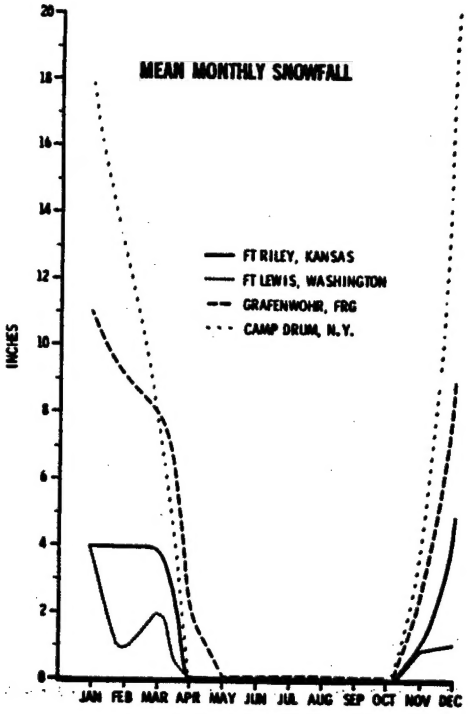

FIGURE 9

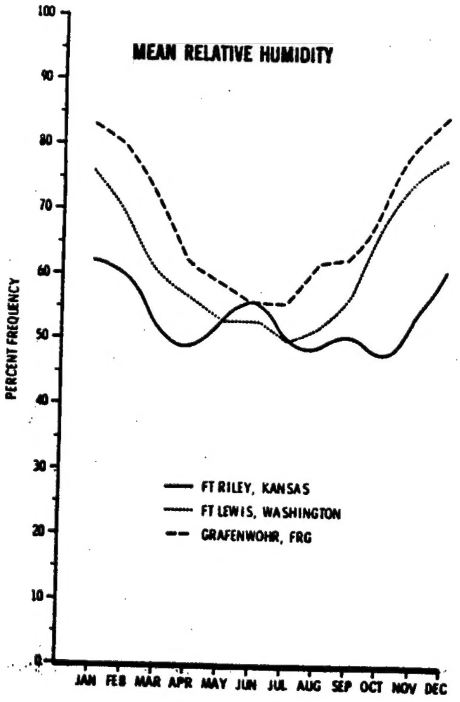

FIGURE 10

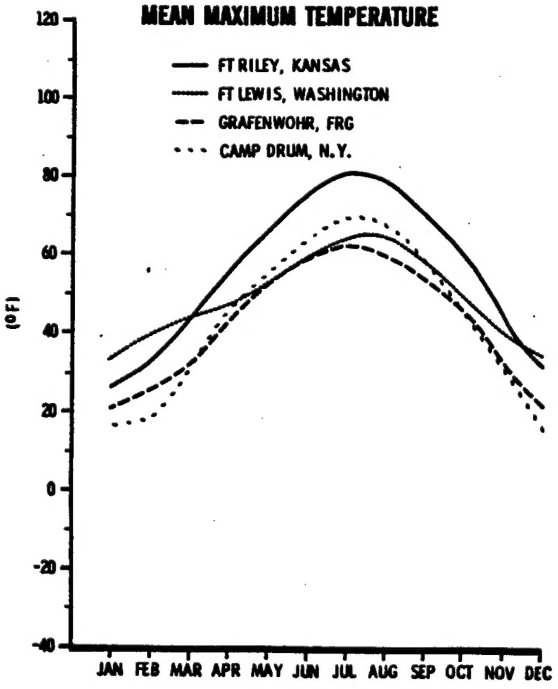

FIGURE 11

More significantly, test sites must be selected so as to emphasize the frequencies of occurrence of specific meteorological conditions needed to demonstrate the system's utility. For the IR Maverick, ceiling and visibility are most important and the specific conditions would seem to be those between 2,000 ft and 4 miles and 500 ft and 1 mile. Above 2,000 ft and/or 4 miles, experienced fighter pilots indicate that visual systems would probably be most cost effective. Below 500 ft and/or 1 mile, radar navigation and guidance are mandatory. In Europe, during January, the weather is between 2,000 ft and 4 miles and 500 ft and 1 mile 40 percent of the time, whereas none of the selected test sites have these conditions any more than 15 percent of the time (See Figure 12). One of the candidate test locations suggested was Eastern Canada. One study plotted 5 and 10 percentile conditions for each month of the year for Grafenwohr, Federal Republic of Germany, and Petawawa, Ontario, Canada to show the similarity of the two locations (See Figures 13 and 14). At these two percentiles, the sites are very similar. However, the 20 and 50 percentile conditions at Petawawa are respectively 2,000 ft and 3 miles and 9,000 ft and 7+ miles while at Grafenwohr they are respectively 800 ft and 1 3/4 miles and 2,000 ft and 4 miles. This means the chance of experiencing weather between 2,000/4 and 500/1 in Eastern Canada is only 40 percent of that in the Federal Republic of Germany (See Figure 15). Either more tests or more test time would be required to get the necessary information in Eastern Canada. In this case, Eastern Canada does not look much better for experiencing critical weather events than selected test sites.

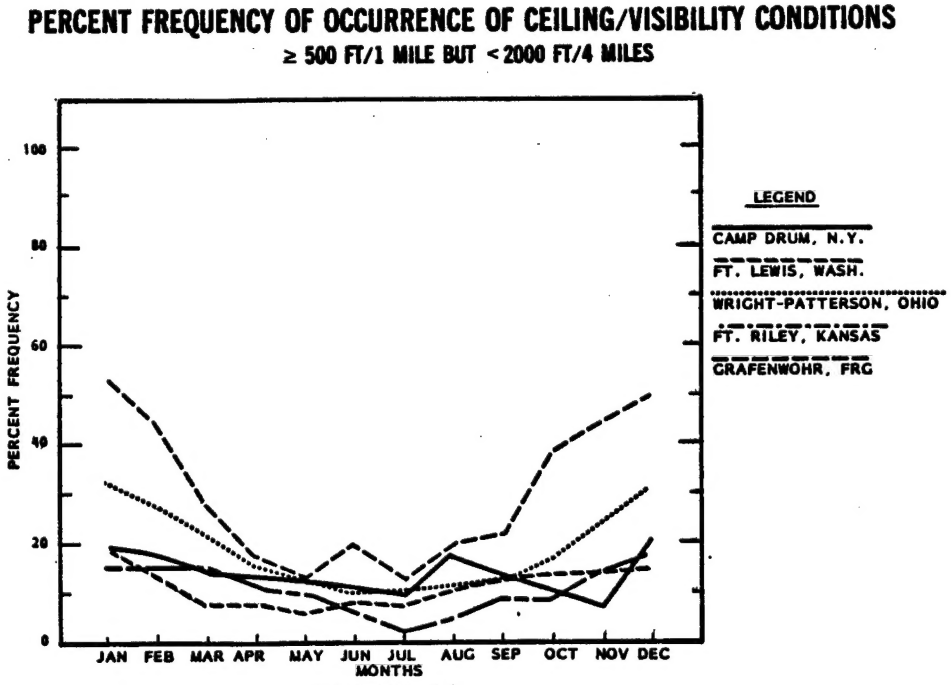

FIGURE 12

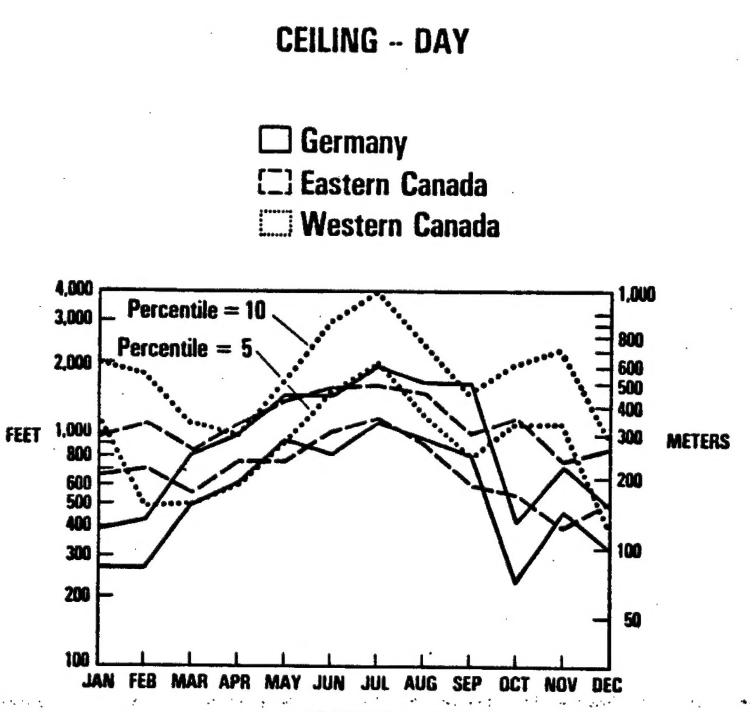

FIGURE 13

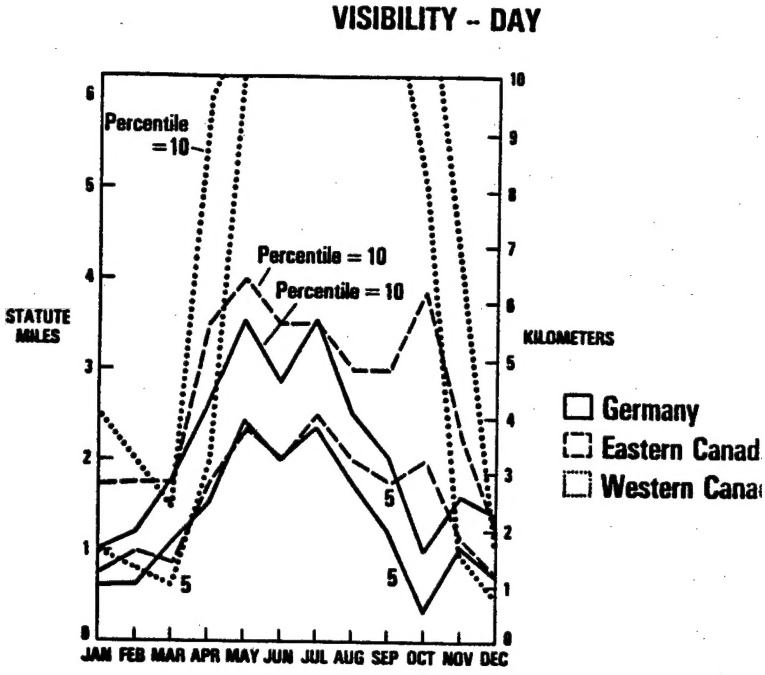

FIGURE 14

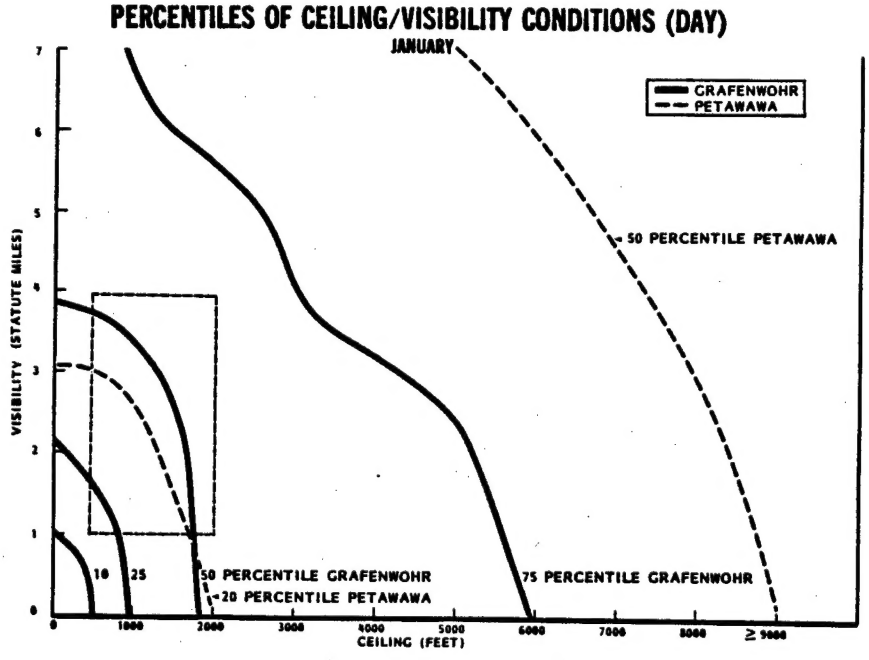

FIGURE 15

Although careful consideration of specific meteorological conditions may be a problem, test site selection strictly with respect to the environment is usually not possible. Site selection is often dictated by consideration of other factors. These include the availability of test support, large controlled access areas, weapon impact areas, test instrumentation, and unrestricted airspace for maneuvering of aircraft. In other words, basic logistical and support capabilities become the limiting considerations as to test site selection. Flight safety regulations also typically limit testing in adverse weather through altitude restrictions. Thus, it is difficult to arrange flight test profiles that realistically reveal environmental limitations. Even if testing is done in the operational area, testing during proper environmental conditions is not ensured. As can be seen in Figure 16, none of the 1978 Baumholder IR Maverick tests were done within the 500 to 2,000 ft ceiling/1 to 4 miles visibility situation.

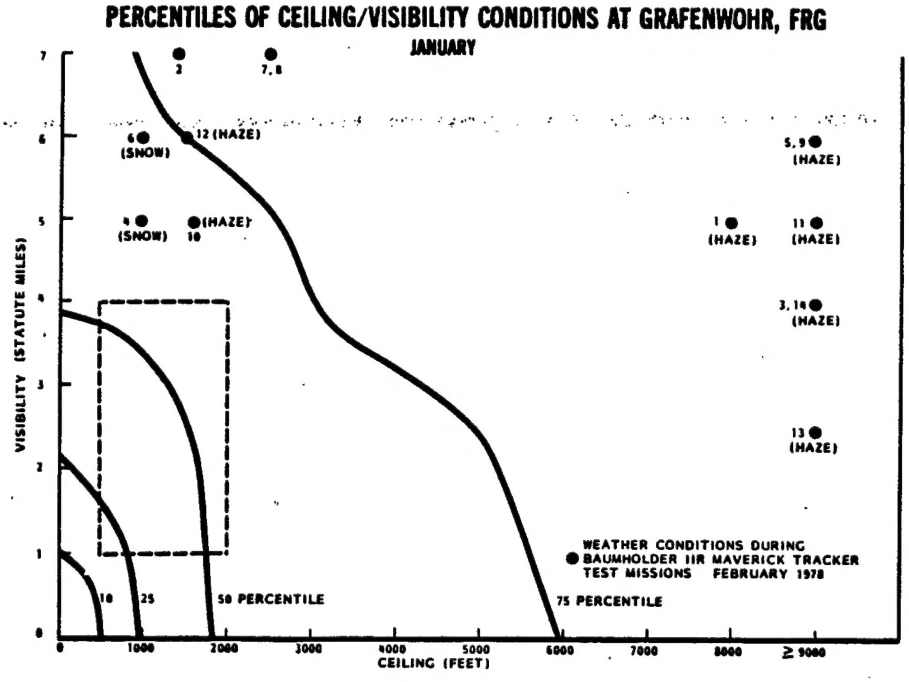

FIGURE 16

In short, logistical factors figure strongly in test site selection. This includes the availability of instrumentation. Measurements must be made in the right locations with sufficient precision and frequency to define needed test data. This is true for meteorological and non-meteorological variables. Supportability of participating aircraft and personnel also tend to favor existing ranges.

The above situation creates a serious problem in meeting DOD requirements to do environmental testing. Therefore, novel approaches and careful planning are necessary for rational weapons procurement decisions. For example, the IR Maverick program is testing the production seeker at the E-O Tower Facility at WPAFB, Ohio to obtain performance data in adverse weather situations (i.e, less than 2,000 ft and 4 miles visibility). Captive flight tests of weather sensitive systems aboard low-cost-to-fly vehicles such as helicopters and light aircraft should be considered. Such tests supplemented with well designed simulations may be able to provide much of the information needed to quantify performance in adverse weather environments. Likewise, careful planning of flight tests should be done so as to be prepared to take advantage of opportunities to test during adverse weather periods. During such times, other scheduled tests or range activities may be cancelled. This may make short notice test time available to a program prepared to take advantage of it. Of course safety considerations must remain consistent with the proposed test.

In summary, this paper has discussed the requirement for environmental testing in order to make the right decisions concerning weapons procurement and associated problems. It has used the Infrared Maverick to illustrate what considerations are needed with respect to the environment. An equivalent system could have been selected. Care is necessary to insure that the right environmental variables from among many are chosen. Further care is needed to test when the values of these variables are such that the test will illustrate the systems performance in adverse weather. If at all possible, tests should be done at locations with weather like that of the principal theater of employment. If this is not possible, special tests and simulations must be conducted to establish system performance in weather. This will insure that information concerning system performance in weather is provided for program decision milestones.